

WORKING PLAN FOR A STUDY OF THE EFFECT OF CLIMATIC AND
OTHER ECOLOGICAL FACTORS ON INSECT LOSSES IN THE
PONDEROSA PINE TYPE OF NORTHERN CALIFORNIA

The theory has long been held by various investigators that climatic factors are related to losses caused by the western pine beetle in the ponderosa pine forests of northern California. It is logical to suspect that a relationship exists, for these factors affect every form of life, and are known to be intimately associated with insects injurious to agricultural crops. However, attempts to use such records as are available from Weather Bureau stations have failed to show any consistent correlation between climatic factors and insect caused losses in timber stands.

Before intelligent recommendations can be made for the control of the western pine beetle through variations in management practices, it is essential that a better understanding be obtained of the effects of climatic and other ecological factors on both the insects and the forest. Since this understanding cannot be obtained through analyses of existing records, chiefly because records are not available for forested areas where the losses have occurred, it has become necessary to set up in the forest a special study of these factors in relation to damage.

I. OBJECTIVES

The primary objectives of this study are as follows:

1. To determine such quantitative differences in climatic or other ecological factors as may exist as the underlying reasons for differentiation in bark beetle damage in various stands of ponderosa pine.
2. To determine which factors are important and how they affect:
 - a. The western pine beetle and its activities.
 - b. The host trees, and indirectly the insects.
3. To determine if the measurements of these factors can be used in predicting fluctuations in loss.

II. SCOPE

On the principle that the approach to a problem of this nature should proceed from the specific to the general, initial work in 1939 was started on a relatively small unit of approximately 250,000 acres of forest in which are represented most of the mixtures and degrees of loss common to ponderosa pine stands in northern California in the East Side Sub-region. The early work was exploratory in nature, and designed to develop standard methods and techniques for evaluating the various factors. It was expected

that if significant differences could be shown in the factors operating in various parts of this area, it would later be possible to confirm or supplement these findings by studies spread over a much wider area.

An expansion of this study is contemplated, during the coming season, to sample conditions in a typical West Side area. Only those climatic factors which appeared dominant in the 1939 program will be studied in the expanded program.

III. LOCATION OF STUDY

Eastside

The area in which intensive investigations are now being carried on has been designated by P. C. Johnson in his Hazard Inventory of the east side forests of California as the Burney Area. This unit is located in Shasta County, and includes part of the Shasta and part of the Lassen National Forests. It comprises approximately 250,000 acres of land covering three watersheds. About 215,000 acres of this area is forested. The ownership is almost evenly divided between Federal and private parties. Permission for the use of this area for the type of studies now in progress has been secured from the owners. Large areas of forest land adjacent to the Burney Area provided ample space for the expansion of this study as necessary.

Westside

A tentative selection of the westside area for the expanded program has been made in the southern Sierra which can be effectively covered from the Miami Field Laboratory. This includes the area from North Fork to and including the southern part of the Yosemite National Park. This area furnishes a good cross section of west side conditions ranging from very poor to very good site conditions.

IV. METHOD OF STUDY

Since the timber stands in the Burney Area have already been classified by Johnson according to four insect hazard zones, the present study has been set up to utilize these zones as fully as possible. The method of study is to measure, observe, and analyze in each zone the various climatic, ecological and biotic factors involved. Investigations are now underway on the following points:

1. Climate
2. Soil
3. Western pine beetle populations
4. Tree growth and physiology
5. Losses in timber stands

V. MEASUREMENT OF FACTORS

A. Eastside

1. Climate

In order to evaluate climatic factors, complete weather stations conforming to standards set by the U. S. Weather Bureau, have been established in each of the four Hazard zones, with an additional master station in Hazard IV at the Hat Creek Field Laboratory. During 1940 the four standard stations will be operated from March 15 to November 1, while the Hat Creek station will be operated all year. Observations will be made each Monday, at which time charts will be changed and checks made on the accuracy of all recording instruments.

A. Temperature. Continuous air temperature records will be obtained from Fries hygrothermographs, which will be checked against maximum and minimum thermometers. Monthly readings on the latter will be taken on all stations throughout the winter.

B. Moisture.

(1) **Relative Humidity.** Continuous relative humidity records will be obtained from the hygrothermographs, which will be periodically checked against readings from fan psychrometers.

(2) **Precipitation.** The Alter shielded storage gauge, adapted to catch both rain and snow, will be used to measure precipitation at all stations except Hat Creek. At this station a recording gauge, furnished by the Weather Bureau, will be used. Precipitation records will also be obtained at 10 additional points in the Burney area by the use this summer of standard Fire Weather rain gauges, which will be replaced by the Alter shielded gauges in the fall. Additional winter records will be obtained monthly from snow surveys made on courses established near the five weather stations and at 2 precipitation stations. Supplemental information on the snow depth on six other courses, maintained in this area by other observers, will be obtained through the California Cooperative Snow Survey.

(3) **Evaporation.** Evaporation from a free water surface will be measured by the use of a 4 foot open pan evaporimeter, and a point gauge. Tests on the rates evaporimeter are contemplated for this season.

C. Wind. At Hat Creek, wind movement, in terms of total miles of air moving past the instrument, will be measured with a recording anemometer. It will be necessary to install this equipment at the other four weather stations before this factor can be evaluated in a comparative way.

D. Light. Further work is necessary to develop a recorder for measuring duration of sunlight during each day. This installation will be made only at the Hat Creek station.

2. Soil

Factors directly connected with the soil are considered of primary importance, since they affect the host tree and indirectly the insect. It is planned to expand the investigation of soil factors during the 1940 season.

A. Temperature. Soil temperatures will be obtained at each weather station by the use of three maximum-minimum soil thermometers inserted in the ground at the following levels: 1", 6", and 16". Continuous records at the 6" depth will be obtained by the use of a Foxboro thermograph at all stations except Hat Creek. At this station a Fricz 3-pen soil thermograph will be operated which will furnish continuous records at all depths.

B. Moisture.

(1) Moisture Content. Soil moisture content, based on oven-dry weight, will be determined biweekly near all weather stations, by taking four samples of approximately 100 grams apiece at each of the following depths: 2", 9", and 16". A soil moisture survey will be made in the Burney Area by sampling all survey plots in the same manner, once at the beginning of the summer, and once again when the moisture curve has reached its lowest level.

It is planned to investigate recently developed electrical conductivity methods for determining soil moisture; also to test the use of porous porcelain cylinders filled with soil and placed at different depths in the ground in such a manner that they can be removed and weighed periodically. Any method that will speed up the determination of soil moisture without sacrificing any further accuracy will be of considerable help.

(2) Seepage. Determinations of the amount of precipitation reaching the subsoil during the rainy season will be continued at each weather station.

(3) Evaporation. Tests will be made during 1940 on the use of trenched plots in which periodic samples of soil moisture can be taken to determine the amount of water evaporated from the soil.

(4) Wilting Coefficient. The percent of moisture present in the soil when plants permanently wilt will be determined by the use of sunflower seedlings. This coefficient will be determined for soil from each of the four study areas.

C. Physical Properties. A mechanical analysis will be run on each soil to determine the percentage of the various separates. It will also be necessary to determine by standard procedure: specific gravity, volume weight, and pore space before the amount of water in any given unit of soil volume can be calculated.

3. Western Pine Beetle

A. Sampling Populations. In order to be able to evaluate the effects of environmental factors on bark beetle abundance, it is necessary to develop direct methods for sampling the population. A study will be made during 1940 to determine, both by counts and by the use of tree cages, the attack-emergence ratio for each brood. It is expected that if this ratio can be accurately measured it may be used as a basis for forecasting fluctuations in timber loss. Investigations will be made of the distribution of the population on various sides and at various heights in infested trees.

B. Generations. To check on the indications that there are differences in the number of generations of western pine beetle in different hazards, forced attack studies will be carried out. Material containing identical stages will be caged on two trees in zones II and V early in the spring, and development followed through successive generations, transferring cages to additional trees as necessary for the balance of the season.

4. Tree Growth and Physiology

A. Growth.

Since the effects of climate and soil factors are reflected in the growth of the trees, investigations on this characteristic will be continued in 1940. Fast tree growth will be determined from increment cores of trees located near each weather station. Current rate of growth for ponderosa pine will be determined in terms of both diameter and height. The former will be measured with growth bands and the latter with calipers. These measurements will be obtained on five poles and five small trees near each weather station and near the 10 precipitation stations. Continuous growth records on mature trees will be obtained by the operation of dendrographs at Hat Creek. Measurements will also be made of current and past needle growth for all intensive study areas.

Germination and survival of pine seedlings will be tested in each area by planting seedspots during the spring. In addition to furnishing a basis for measuring the success of establishment of subsequent crops, it is expected that these seedlings will attract cutworms. (Specimens of these insects are needed in connection with other studies). In addition, they are expected to furnish a practical field test of wilting coefficient.

B. Physiology

There is a great need in Forest Entomology for developing some quantitative measure which will accurately reflect a tree's physical condition, such as the indicators of pulse rate and temperature in human physiology.

Preliminary work of this character will be attempted during the current season. These studies will include periodic measurements of moisture relationships in various parts of the tree to include needles, twigs, roots and trunk. Also examinations will be made of root systems of trees which show varying stages of crown decadence. In addition, preliminary work on tree conduction will be attempted.

5. Losses in Timber Stands

The weather stations have been set up to measure factors on small areas in each of four Hazard zones. As losses occurring in these units are likely to be highly variable, it has been necessary to extend the sampling through each zone.

A preliminary sampling study indicated the theoretical high efficiency of 20 acre plots as compared with 320 acre plots. As a result, plans have been made to establish 50 twenty-acre sampling units in the Burney Area. These units have been assigned at random to each Hazard zone in proportion to the total area in each zone. The distribution is as follows: Hazard II, 15 plots; Hazard III, 23 plots; Hazard IV, 11 plots; Hazard V, 1 plot. Ten of these plots will serve for research purposes, and the balance are intended chiefly for survey purposes. Five of the research plots and 28 of the survey plots have been set up, leaving 17 plots to be established this year. The laying out of these plots will require the services of a three man crew for approximately 1½ months. Since only one of the 33 plots laid out in 1939 was completely inventoried, a two man crew will be necessary for the balance of the season.

An attempt will be made to cruise all plots by broods during 1940, to determine the type and extent of damage caused by each.

Loss records in the Burney Area on permanent sample plots will be supplemented by a series of road strips, 10 chains in width, run through each of the broad hazard zones. If time permits, these records may be further supplemented by a series of "high point" observational surveys.

VI. INVESTIGATIONS ON WESTSIDE AREAS

The expanded program on the westside, for the first season, will cover the following points: Climatic studies and observations on the insect complex of that area.

1. Climatic Factors

There exist at the present time two rather complete weather stations in the westside area selected for study. There are maintained by the California Forest and Range Experiment Station as part of their intensive study of Forest Influences. One of these is located at Northfork and the

other at Bass Lake. Informal approval has been secured to use any of these records which we might desire. These are permanent all-year stations and practically all the records which we are taking at Hat Creek are being taken there. The Northfork station samples an area approaching fringe conditions in westside approximating site IV for ponderosa pine, while Bass Lake samples conditions between site III and IV. To supplement these records the Forest Insect Laboratory will install and maintain two additional stations in better sites. One of these will be located near the Miami Laboratory on the Hugh Ryan permanent sample plot. The other will be located near the Mariposa Grove in the Yosemite National Park. The former samples a site condition of III and the latter site II. For the first season, hygrothermograph records and those of maximum and minimum air temperature and precipitation records will be the only ones studied. If time permits, a preliminary sampling of soil moisture will be made late in the summer.

2. Growth Records

For the first season height growth on five saplings and diameter growth on five poles will be made at the end of the growing season. The following year these measurements will be standardized with those being taken at Hat Creek.

3. Loss Records

Loss records with which to correlate climatic factors will be obtained by a reconnaissance survey supplemented by records from permanent sample plots which are located in this area.

4. Insect Studies

These will be similar to studies at Hat Creek except that more attention will be given on the westside to the activities of the mountain pine beetle.

Respectfully submitted,

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